LUBRICATION

Published by THE TEXAS COMPANY

17 Battery Place, New York City

Copyright, 1917, by The Texas Company

Edited by

L. H. CANFIELD, Ph. D.

VOL. IV JULY, 1917 No. 9

Published Monthly in the interest of efficient lubrication.

Change of Address—In reporting change of address, give both old and new address.

Reprints—Permission to reprint articles will be granted, provided credit is given to the author and to "Lubrication."

Correspondence is invited. Address all communications to Dr. Canfield.

CONTENTS

	PAGE
Editorials	1
United States Naval Awards	2
Lubrication of Diesel Engines	5
A New Record for Texaco Cetus Oil	10
Herringbone Gear Lubrication	11
Texaco Service	12

EDITORIALS

Probably few people stop to realize the important part played by lubrication in the conduct of war. Whether it be in the operation of aeroplane, submarine, battleship or ordinary field artillery, efficient lubrication is absolutely essential. The most important single phase of the lubrication of war material, however, is the lubrication of the battleships, submarines, destroyers, aeroplanes, submarine chasers, etc., connected with the Navy. This work requires every type of lubricant from the heaviest internal combustion engine oil to ice machine oil; and from steam cylinder oil and hot-running torpedo oil to a heavily compounded marine engine oil. In an article on the Navy awards, published in the July, 1914, issue of *Lubrication*, attention was called to our contract for the fiscal year beginning July 1st, 1914. Since that time we have had yearly contracts with the Navy calling for a very large percentage of their lubricating oil requirements. The fact that the contract for the ensuing year for practically all of the lubricating oil to be used by the Navy has been awarded to The Texas Company pays a most eloquent tribute to the quality of Texaco oils and to the service rendered by The Texas Company.

Mr. DeMary's article on the lubrication of Diesel Engines, reprinted in this issue, is of particular interest in connection with the letter quoted at the end of the article, in which Mr. DeMary states that he has used nearly every oil on the market and that the "best lubricants" that he has found are Texaco Ursa Oil and Texaco Alcaid Oil.

We have had occasion to refer many times to the work of Texaco Cetus Oil, but the record in the case mentioned in this issue is the best yet. Texaco Cetus Oil is now being recommended or has been accepted by all of the leading turbine manufacturers of the country.

UNITED STATES NAVAL AWARDS

By Frank J. Shipman

THE Texas Company's contracts with the United States Navy for furnishing lubricating oil during the fiscal year ending June 30, 1917, will have ended before this article is published. We will have delivered under that contract over one million gallons of lubricating oil for the Navy's fighting units and its auxiliary vessels. It is with gratification that we look back at the performance of Texaco lubricants during this past year, as we have no record of any complaints either as to the quality of the oil furnished or as to the service rendered in delivering this enormous quantity of lubricating oil to the many points in the United States as well as in the Orient.

In May of this year, the Navy Department, under Schedule No. 924, advertised for their supply of lubricating oils for the United States Navy, as well as for the Coast Patrol for the ensuing year. We now have notice of award to us of practically the entire lubricating oil business of the United States Navy, the one exception being an ordnance item of 1,500 gallons for delivery on the Pacific Coast and to the Orient.

The award contemplates delivery during the fiscal year ending June 30, 1918, as follows: at Atlantic ports 835,000 gallons; at Pacific ports 257,000 gallons; to Oriental ports 71,000 gallons. Delivery in this latter case is made f. o. b. San Francisco. Our contract also provides for delivery of oil to the Panama Canal, as well as to foreign ports f. o. b. Norfolk, Virginia.

We are all more or less familiar with the contemplated coast patrol which is now in actual operation, and which no doubt will be greatly increased in size. Our contract provides for delivery at some fifty points on the Atlantic and Gulf coasts to Coast Patrol vessels. The gallonage to be delivered to these vessels is not included in the figures given above.

The contract which has just been awarded The Texas Company is the largest one we have entered into with the Navy Department. Inasmuch as the size of the Navy has increased, the quantity of oil required will naturally be greater than on any previous contract given out by the Navy Department. A list of the oils, showing the uses to which they are put in the Navy, is given below, the numbers corresponding to the numbers on the new Navy contract.

TEXACO LUBRICATING OILS WHICH WILL BE SUPPLIED BY THE TEXAS COMPANY, CONTRACT NO. 30559 WITH THE NAVY DEPARTMENT, FISCAL YEAR ENDING JUNE 30, 1918.

Atlantic Ports, Class 1, Items 1, 2, 3, 4, 5 6, 7, 8, 9, 10, 11.

Pacific Ports, Class 2, Items 1, 2, 3, 4, 5, 6, 7, 8, 10.

Oriental Ports, Class 3, Items 1, 2, 3, 4, 5, 6, 7, 8, 10—f. o. b. San Francisco.

Atlantic and Gulf Ports. Class 5, Items 1, 2, 3, 4, 5, 6, 7, 8.

Item 1—Texaco Pinnacle Mineral Cylinder Oil.
Viscosity 130″ at 210 deg. F. A heavy mineral cylinder oil possessing fine lubricating qualities, for use on piston and valve rods; can be used under all conditions of steam.

Item 2—Texaco Spica Oil.
Viscosity of 100″ at 100 deg. F.; cold test 5 deg. below zero F. For lubrication of the compressor and expander cylinders of ice machines and for pneumatic tools. It is light in body and color; can be used in hydraulic systems; also for cleaning small arms. Will not gum or corrode.

Item 3—Texaco Algol Oil.
A heavy oil. This is a straight mineral oil, has a viscosity of 500″ at 100 deg. F.;

cold test 5 deg. F.; will not saponify or mix with water. For lubrication of internal combustion engines of motor boats, submarines and aeroplanes; also for lubrication of main engines on forced feed, for turbines of heaviest type; on destroyers having a combination of turbines and reciprocating engines.

Item 4—Texaco Alcaid Oil.
A medium oil. Viscosity of 300″ at 100 deg. F.; zero deg. cold test. An excellent turbine and forced lubrication oil if one of this viscosity is desired. For lubrication of internal combustion engines of motor boats, submarines and aeroplanes, air compressor cylinders and bearings.

Item 5—Texaco Cetus Oil.
A light oil. Viscosity of 200″ at 100 deg. F.; zero cold test. For turbines, dynamos and internal combustion engines, where a light viscosity oil is desired, and for general oil about ship.

Item 6—Texaco Ursa Oil.
An extra heavy oil. This is a straight mineral oil; has a viscosity of 750″ at 100 deg. F.; cold test 5 deg. F.; recommended for lubrication of large internal combustion engines of motor boats, submarines and aeroplanes; also for lubrication of main engines on forced feed, for turbines of heaviest type, or destroyers having a combination of turbines and reciprocating engines; also Diesel engine cylinders, air compressors and bearings.

Item 7—Texaco Altair Oil.
This is a straight mineral oil; has a viscosity of 500″ at 100 deg. F. This oil is dark red in color. Will not saponify when mixed with water as readily as a compounded oil. Suitable for lubrication of main engines (for wick or hand feed).

Item 8—Texaco Neptune Marine Engine Oil.
This is a compounded oil made to saponify with water, for lubrication of reciprocating engines and auxiliaries where oiling is done by hand or through wick feed or drop oilers; also thrust bearings. This oil is not suitable, nor intended, for other purposes.

Item 9—Texaco Hot Running Torpedo Oil.
This is a specially compounded oil for lubrication of hot running torpedoes.

Item 10—Texaco Alcaid Oil.
See Item 3.

Item 11—Texaco 650 T Mineral Cylinder Oil.
This is a straight mineral cylinder oil; has a viscosity of 150″ at 210 deg. F.; is recommended for lubrication of steam cylinders using superheated steam.

The Texas Company has given the Navy the best possible service, and the award of the contract referred to is virtually a continuation of our last year's contract. We have made no change in the oils to be furnished, but are furnishing three additional oils, Texaco Altair Oil, Texaco Hot-Running Torpedo Oil, and Texaco 650 T Mineral Cylinder Oil, all of which have been tested and approved for the purposes mentioned in the list.

We are quoting from an article written by Lieutenant Commander H. T. Winston, U. S. N., Member, reprinted from the Journal of the Society of Naval Engineers, May, 1917, issue, p. 251, under the heading "Navy Lubricants and Lubrication." This extract indicates very clearly that the oils used for lubricating the units of the U. S. Navy are not purchased with price as the only consideration. The important factor is quality, and it must be said with pride that the fact that we have enjoyed a large portion of the business of the United States Navy for the past eight years is conclusive proof of Texaco quality.

APPENDIX A

Information Concerning Tests of Lubricating Oils at the Engineering Experiment Station.

Issued by the Bureau of Steam Engineering. Subject to change or modification as found desirable.

February 7, 1916.

1. All oils not known to be satisfactory are subject to test at the Engineering Experiment Station, Annapolis, Md., and to a further test in service on board ship when considered necessary, before being considered acceptable by the Bureau of Steam Engineering.

2. Authorization of an oil test must be obtained from the Bureau of Steam Engineering, which Bureau directs the Engineering Experiment Station to conduct the test. The authorized tests are then given a number and are taken up in regular order; persons interested being permitted to visit the Experiment Station and inspect the methods of testing employed.

3. All expenses of tests are borne by the

concern requesting the same; the necessary quantities of oils being shipped to the Supply Officer, Naval Academy, Annapolis, Md., *marked "For Test at Engineering Experiment Station,"* and with all express or other charges prepaid. Before the test is started a check made payable to the *Superintendent, U. S. Naval Academy*, must be mailed to that official at Annapolis, Md., to cover the costs of tests; any unexpended balance being returned to the exhibitor.

4. All tests are made with the strict understanding that they are for the information of the Government only and that results of tests are not to be used as an advertisement.

5. The cost of tests varies with the labor involved and the number of oils tested, the expense being reduced where an oil proves unacceptable in the early stages of the test.

6. In general, a deposit of $50.00 is required for a test of one oil and $200.00 for 6 or 8 oils, the amounts of each oil required by the Experiment Station being from 5 to 20 gallons.

7. The complete test of an oil consists of three parts, namely: chemical, physical and practical tests.

8. To successfully pass the *chemical* tests *all* oils should be neutral in reaction and should not show the presence of moisture, matter insoluble in petroleum ether (hard asphalt), matter insoluble in ether alcohol (soft asphalt), sulphur, charring or waxlike constituents, naphthenic acids, sulphonated oils, soap, resin, or carry constituents, the presence of which indicates adulteration or lack of proper refining. Except in oil for engines without forced lubrication, no traces of fixed oils (animal or vegetable fats) should be found.

9. In lubricating oil for main engines without forced lubrication, approved fixed oils, such as rape seed, olive, tallow, lard and neatsfoot oil may be used. When the above fixed oils are used, they will be well refined with alkalies, unadulterated, containing a minimum of free fatty acids, with no moisture or gumming constituents. Olive oil should not have a high specific gravity. If satisfactory emulsifying results can be obtained with straight mineral oils on engines without forced lubrication they may be submitted for service test.

10. The *physical* tests applied to *each* oil are as follows:

(a) Specific gravity—pyknometer, Baumé gravity.

(b) *Flash* and *Fire Point* (Cleveland open cup, Pensky Martin closed cup). The flash point should not be below 300 fahr., closed cup; and for steam cylinder oil not below 450 fahr.

(c) *Cold Point.* The cold point should not be above 32 fahr., except for cylinder oils. For ice machine oils it should be as low as possible, at least low enough for the operating condition of minus 15 fahr. in a dense air ice machine.

(d) *Viscosity.* The Saybolt Universal Viscosimeter is used. The viscosity of the oils must be sufficient for the purpose intended, and, except for ice machine oils, must not be less than 140 seconds at 100 fahr. Viscosity is taken at 100, 130 and 210 fahr.

(e) *Emulsion tests.* Emulsion tests are made on all straight mineral oils, except cylinder oils. Four emulsion runs are made, using 40 c.c. of oil in each case, and

(1) 40 c.c. of distilled water;
(2) 40 c.c. of salt water;
(3) 40 c.c. of normal caustic soda;
(4) 40 c.c. of boiling distilled water.

The mixture is stirred with a paddle for five minutes at 1500 revolutions per minute, the mixture being kept at a temperature of 130 fahr. during the stirring and while settling out. On oils used with forced lubrication or on ice machines the oil must completely settle out in less than 30 minutes.

(f) *Friction tests* are made on the Experiment Station friction machine to determine the relative friction of various oils under varying conditions of speed, bearing-cap pressures, and temperatures.

11. *Practical tests* of oils for forced lubrication are made on the Engineering Experiment Station's 75-kw. turbo-generator, making 2,400 revolutions per minute, with the temperature of the bearing varying from 180 to 210 fahr. Tests of ice machine oils are made on the ½-ton Allen Dense-Air Ice Machine. These tests cover a working period of at least 100 hours.

12. Upon the completion of the tests at the Engineering Experiment Station a service test is usually recommended on all but cylinder oils. These tests are made on ships in commission, and cover a period of several months. The oil for this test is paid for at the price of the contract oil in use for the purposes intended.

13. Oils should be submitted as follows:

(a) Three oils (light, medium and heavy) to be suitable for turbines, all forms of forced-feed or splash lubrication, dynamo engines, and all internal-combustion engines (including Diesel type). These three oils should cover

the required range of viscosity. The pour point must not be above 15 degrees F. for the medium and light oils.

(b) Marine engine oil suitable for main engines without forced lubrication. This oil should form an emulsion when mixed with water, and may be either a compounded oil or a straight mineral oil. This oil must feed efficiently with wick feed, and not be washed off when mixed with water.

(c) An oil for use on ice machines in both the compressor and expander cylinders. This oil should not give off an objectionable odor when used with the Dense-Air Ice Machine.

(d) Oil for steam cylinder lubrication. This oil must be a straight mineral oil.

(e) Oil for steam cylinders using superheated steam. This oil will be used only on shore stations and should have a high flash point.

14. It is desired to have the trade names of the oils indicate the use for which they are submitted. For instance, "Cetus 200 Mineral" would indicate, first, the trade name: "Cetus"; second, the viscosity, Saybolt at 100 fahr.: "200"; and third, the kind of oil: "Mineral." For marine engines without forced lubrication a name such as "Neptune Marine Engine" or "Atlantic Marine Engine" would indicate the use, no matter whether the oil were a compounded or a straight mineral oil. For ice-machine oils names such as "Polar *Ice* Machine" or "Spica *Ice* Machine" will do. And for cylinder oils such names as "Pinnacle *Mineral Cylinder*" or "600-W *Mineral Cylinder*" are suitable.

15. It is necessary that the trade name of the oil furnished the Engineering Experiment Station for the original test be the same as that furnished for service tests.

16. When the contract is awarded, the oils furnished on contract must be identical with those sent to the Engineering Experiment Station for the original acceptance test.

17. As correspondence and arrangements in connection with tests, the actual conduct of tests, and unforeseen contingencies, frequently consume many months, *prospective bidders should submit their oils* for test *eight months before they intend to bid* for Government contracts.

18. Oils for *Torpedo Lubrication* and *Torpedo Air Compressors* are under the *Bureau of Ordnance* and subject to the tests prescribed by that Bureau.

LUBRICATION OF DIESEL ENGINES*

By R. C. DeMary

DURING my fifteen years experience as an operator and erector of steam and Diesel engines, I have come in contact with some of the best engineers in the United States. Until the coming of the internal-combustion engines, little attention seemed to be given to lubrication, but difficulties began to arise, which were attributed to lubrication and a closer study of the important function has resulted. However, the average engineer is still weak on the subject and can hardly be expected to be otherwise as there is very little literature relating thereto and that is written in such a manner that it is of no practical use to him. Nearly all articles I have come in contact with are too technical or else written in the interests of some special brand of oil. In the following discussion I will endeavor to be as practical as possible, so that the Diesel engineer may be assisted in his lubrication problems.

We all know that two metal surfaces rubbing together cause friction and that to reduce this friction we must use some kind of lubricant. This lubricant or oil must form a film that will entirely separate the two metal surfaces. We might say that the bearing surface floats on a film of oil.

A lubricant must possess three characteristics as follows:

*Reprinted by permission from *The Gas Engine*, April, 1917, p. 170.

First—It must be capable of forming a film between two surfaces.

Second—It must have low friction qualities in itself.

Third—It must resist being squeezed from between the surfaces.

There are other qualities which a good lubricant for Diesel engines must have, but these three are the fundamental ones.

If an engine runs without giving trouble of any kind we know that it is well designed and that a good oil is being used. If trouble occurs we are sure of one or more possibilities:

First—The oil may be poorly refined.

Second—It may not be fed to the cylinders in the right amount.

Third—It may be a good oil, but not suited for this particular engine.

Fourth—The engine or lubricating system may not be properly designed.

Trouble due to the first case is quite frequently encountered, though not so often where well known brands of oil are used. The second case depends upon the vigilance of the engineer. In the third case it may be necessary to change oils and use one that is better suited to the engine. Fortunately trouble due to the last mentioned case is exceptional.

Lubricating conditions which are met with in the operation of Diesel engines are much more severe than with steam.

A suitable lubricant for the former must have the three following requirements:

First—It must lubricate the piston in an efficient manner at the high temperatures encountered.

Second—It must seal the piston and rings to prevent leakage.

Third—It must burn without forming carbon in the cylinder.

The first requirement is an important one and depends on the viscosity, or in other words, its resistance to flow. The higher the viscosity the less fluid the oil, and this property decreases greatly as the temperature increases. Viscosity is generally expressed as light, medium, heavy, etc., though the viscosity of light, medium, and heavy oils may vary with different brands. For instance two light oils of different brands may differ greatly in viscosity. Thus we find that the higher the viscosity the thicker the oil, but we must not lose sight of the fact that all oils decrease greatly in viscosity with a very slight increase in temperature.

I have heard many engineers declare that they were using the "best" oil, yet they had lubrication troubles and always would because of the "extremely high" temperature in the Diesel engine cylinders. Let us see just what these extremely high temperatures are. Continued experiments have shown that a maximum temperature of about 2675 F. degrees is obtained at the starting of the power stroke, or upon ignition of the fuel charge. This temperature is lowered, as expansion of the burning charge takes place, and gradually jumps back to its maximum on the compression stroke. The minimum temperature is about 250 degrees F., with an average of about 945 degrees F., during a complete cycle. Now we must remember that these temperatures are those of the gases and not of the cylinder walls. Now the point to emphasize is the great difference in temperature between the gases and the cylinder walls, since this has an important bearing on cylinder lubrication.

From a series of actual experiments conducted by W. B. Meriam it was shown that the cylinder walls had a temperature of about 30 de-

grees F. above that of the circulating water. Now just as long as the water is not boiling we know that the temperature of the walls is not higher than 250 degrees F. in a Diesel engine.

The action of heat on oils is determined by the flash point and the fire point. The flash point is the temperature to which the oil must be heated in order that the vapors given off will make a slight explosion when a flame is held directly over the oil. The fire point is the temperature to which the oil must be heated so that it will take fire and continue to burn after a flame has been applied. The fire point is from 40 to 50 degrees F. above the flash point.

Practically every oil used on Diesel engines has a flash point above 320 degrees F., and if the temperature rises above that there is something wrong, not with the oil but with the engine. Locate the trouble, and remedy it, but do not feed more oil or change lubricants.

Lubricating oil does not burn readily, and furthermore the time given it in the cylinder is very short. An engine running at only 100 revolutions per minute, would expose the lubricated surface of the cylinder to the action of the flame for less than one-quarter of a second. At higher speeds the time allowed for the oil to burn is so short that a flash point of as low as 300 degrees F. would be sufficiently high for any Diesel engine, except in the most unusual conditions.

The chief trouble maker in connection with the operation of Diesel engines seems to be carbon deposits in the cylinder. The lubricating oil, of course, is blamed for this, when in nine cases out of ten, it is the operator, or in other words, a little more care and reasoning would prevent shut downs.

Carbon exists in two forms: First, fine carbon suspended in the oil and second, in combinations forming hydrocarbon compounds which go to make up the oil. The amount of fine carbon is very small and the trouble from this cause in most cases is due to some other factor.

I have found in nearly every case where trouble was caused by carbon, that the engineer was using more oil than was necessary for the proper lubrication. An over supply of oil in the cylinders will always cause the formation of carbon. Use an oil with an asphalt base, and not too heavy.

The addition of a small amount of graphite (about one teaspoonful to one gallon of oil) will assist in the lubrication and also, I have found, will, to quite an extent, assist in preventing carbon deposits. The amount of oil necessary to lubricate the cylinders of a Diesel engine depends on so many factors that it is necessary to solve the problem for each individual engine.

Oils made from the asphalt-base crudes of the southern States are much superior to any others for Diesel engine lubrication. Those oils having a paraffine base, such as the Pennsylvania crudes, have a very low viscosity and to remedy this it becomes necessary to resort to compounding. The light oils are mixed with the heavier cylinder oils, and the latter is responsible for most of the gumming and carbon troubles due to lubrication. The asphalt-base oils are composed chiefly of the ethylene and the naphthene series* and distil without

*Editor's Note—These oils consist chiefly of hydrocarbons of the series $C_n H_{2n-4}$.

decomposition. No gum will be found in the cylinders or in the valves, and the fine carbon will nearly all be discharged through the exhaust.

The color of an oil, regardless of what the manufacturers claim, has no relation to its lubricating value. You can, however, tell if the oil is compounded with the heavy cylinder oils, for the reason that it will always show the green tinge of the latter.

While every Diesel engine is equipped with a force feed lubricator, I regret to say that many of them are of little use. I have been called on several trouble cases where I recommended a change of lubricators and after installing the one I considered best for that particular case, little or no further trouble was experienced. Now I am not connected in any way with the manufacture or sale of lubricators for Diesel engines, but to my knowledge there is but one which I consider suitable for that purpose. This lubricator is driven by a lay shaft and is so adjusted that the pump plunger works in synchronism with the pistons. The oil is delivered directly onto the pistons, between the rings and at the end of the stroke. Now if we stay to consider for a moment we can see how important such a method is. The oil that does not strike the piston or is forced into the cylinder at such a time as the oil hole is uncovered by the piston is wasted and means just so much more carbon forming material.

Perhaps the following will give a better illustration of the above: Some months ago I was called to investigate a municipal plant in the Middle West, that was having considerable trouble. I found they were using one of the best brands of Diesel engine oils, yet it was not giving the satisfaction expected. I made a careful examination, and among the changes made and recommended was the purchase of a new lubricator. Now to get any kind of service from the oil, 80 to 85 drops per minute were being used in each cylinder. Before I left the city the new lubricator was installed and I again assumed charge of the plant for a short time. I cut down the oil to 40 drops per minute and found even this amount too much. After a few trials I found that about 32 drops per minute gave ideal results and from last reports, no trouble has been experienced at the plant and the "Chief" is greatly enthused because his carbon troubles have been almost entirely eliminated. Furthermore it does not require a great deal of figuring to determine the saving in the cost of oil at the above plant, which is one of the great many I have found in plants equipped in a similar manner.

The whole secret of successful cylinder lubrication is to use a suitable oil, and deliver a proper amount at the proper place and at the proper time.

The amount of oil required to properly lubricate the cylinders of a Diesel engine naturally depends upon several factors. The most important ones are design, style of lubricator, and quality of oil. I have found that where an engine is well designed, and the temperature of the cooling water as it comes from the cylinders is not above 176 degrees F., I obtain best results on a feed of 18 to 20 drops of oil per minute, per cylinder, where the size is not above 16″ in diameter and 25″ stroke. This amount of oil I would consider about right for all dimensions below those given, and where the revolutions do not exceed 160 per minute. Where the bore

is from 16″ to 25″ and the stroke 25″ to 32″ the average amount of oil is 25 drops per minute. With engines of this size the speed is naturally less, and the amount of oil is somewhat lower in proportion. These are average cases. Under some conditions I have found I could reduce the amount of oil mentioned and in others it was more than double the amount given above. The excessive requirement was due to poor rings, that is, rings which leaked badly, and an extra amount of oil was required to maintain a seal between the rings and the cylinder in order to keep up the compression. Where the lubricator is one that feeds the oil in synchronism with the engine piston, the amount of oil may in most cases be reduced a few drops per minute. If on removing a cylinder head a film of oil is found on the walls of the cylinder sufficiently thick to penetrate two thicknesses of cigarette paper, you will know you are getting a sufficient amount of lubricant.

In some cases a lubricator is divided so that one grade of oil is used in the cylinder and another on the bearings. I do not believe in this method as I know of many cases of trouble which were very expensive because the operator made a mistake in the oils. Furthermore the small saving in the cost does not warrant this method. Where the splash system is used, as it is in some cases, the oil from the crank pit should be renewed or filtered every three weeks where the run is twelve hours per day. If the pistons show any signs of leaking the oil should be renewed more frequently. Do not try to save on the oil at the expense of the engine, yet keep in mind that too much oil may cause harm.

Beware of whom you buy your oils and be sure they contain no animal fats. Under ordinary working conditions an oil with a viscosity of not less than 200 at 100 degrees F. and a low cold test is recommended. If your engine is subject to overload, or is so located that the temperature of the room is high, a heavier oil should be used, one with a viscosity of from 300 to 400 and a low cold test. Sometimes the working conditions are very severe, and trouble is experienced from leaky rings and an oil with a viscosity of as high as 600 to 650 may be necessary.

Remember the color of the oil means nothing, neither does the density as a specific property, for when we mention light, medium, or heavy, we are concerned only as to viscosity. Light means low viscosity and heavy means high viscosity. Excessive friction may result from either too high or too low a viscosity. Too high a viscosity will give a good oil film, yet the friction in itself will be excessive. If the viscosity is too low the film will be broken. Get just as thin a film of oil as you can, yet have it perfect, and you have solved the lubrication problem.

All oil should be filtered before using. This may seem needless with new oil but, even under the best conditions, foreign matter will sometimes get into the lubricant and, if filtered, this will be removed and be the means of preventing a serious shut down.

Where the engine has an enclosed crank case and uses the splash system on the bearings, the oil should be renewed frequently and filtered. The oil may seem to be in good condition but you will be surprised at the amount of sediment it contains, and which may prove detrimental to the bearings. We often hear the remark that "oil is cheaper

than machinery," but we must remember that there is such a thing as overdoing the matter.

The appreciation of the foregoing principles should enable any one to obtain an oil suitable for his engine, and to use it in such a manner as to obtain the best results. I also believe that trouble due to carbon can be almost entirely eliminated by a study of its causes, and the use of a little judgment.

In connection with the above article the following letter from Mr. R. C. DeMary may be of interest. Mr. DeMary is in no way connected with the Texas Company:

Akron, Ohio, March 15, 1917.

THE TEXAS COMPANY,
New York City.

Dear Sirs: Some weeks ago I was requested to prepare an article for publication in the "Gas Engine" on the "Lubrication of Diesel Engines." I have had many years experience with all forms of internal combustion engines and have used nearly every oil on the market. In my article I refer to results obtained with certain oils and give what I have found to be the best lubricant. While not permitted to mention names or brands it may interest you to know that the oil referred to was Texaco Ursa and Texaco Alcaid oils. I believe more trouble is caused by imperfect lubrication than from any other source. In many trouble cases I have demanded the use of your lubricants, and they have never yet failed me. Should you desire to use this letter or any part of it, you are at liberty to do so.

Yours very truly,
R. C. DeMary,
138 E. Exchange St., Akron, Ohio.

A NEW RECORD FOR TEXACO CETUS OIL

A LARGE corporation in New Mexico which had been using a well known engine oil in its turbines, charged its fifty-three gallon system with Texaco Cetus Oil in January, 1915. Formerly, the system had been emptied and cleaned out every thirty days for the reason that the competitive oil became too dark and thin, and the turbine heated up too much to continue running the oil. The original charge of Cetus remained in this turbine without change, except for an addition of seventy gallons of fresh oil, made in small lots at irregular intervals, until April, 1917, when samples were taken and sent to our Port Arthur Laboratory for analysis. During this period of over two years the turbine was stopped only once a month for not longer than three hours at a time. The following letter from our Port Arthur Laboratory, under date of June 4th, justifies us in the pride we feel in Texaco Cetus Oil.

"Referring to your letter of May 23rd, regarding a quart sample of Cetus Oil taken from the subject concern's 1000 k.w. Curtis Steam Turbine after having run over 21,000 hours:

	New Oil	Used Oil
Gravity, Baumé	20.0	20.2
Flash	320°	325°
Fire	380°	380°
Viscosity at 100 F.	200″	205″
Pour Test	0	0

I note that this oil has been in the turbine since January 5, 1915. The oil is apparently in perfect condition and has not deteriorated to any extent."

The used oil in a four-ounce bottle has the appearance of a rich light red wine, the color having changed from a light straw. It is perfectly clear and bright without a trace of water or deposit of any kind. When some of the used oil was thoroughly mixed with ordinary tap water in a four-ounce bottle, the water separated out clear without a trace of emulsion between the oil and water. Considering the number of hours run and the condition of the oil at the end of the run, this undoubtedly constitutes a new record for a turbine oil.

HERRINGBONE GEAR LUBRICATION

A GOOD example of gear lubrication has recently been reported by one of our engineers. The plant, which is located in northern New York, was built recently, and therefore the gears were all in good condition.

The gears driving the plate shears had been lubricated with a well known gear shield, but at the time our engineers were there, these gears were very dry, none of the so-called gear shield having remained on them. Considerable noise was being made, due to the fact that the gears were running dry; and also, as they were absolutely dry, it was unnecessary to clean them. After Crater Compound was applied they ran quite noiselessly, and this attracted the attention of all the men in the mill, who commented very favorably on Crater Compound.

Four sets of steel cut gears on a large lathe in the machine shop were also making considerable noise. This noise was reduced considerably by Crater Compound.

Thirty days later an inspection of both the above sets of gearing showed that Crater Compound was still doing splendid work. It had required very little attention to keep the quantity just right in order to allow the gears to run quietly. All of the gears noted above would run noiselessly one entire week without further application of Crater Compound.

A set of gears in another part of the mill that was driven by a 25 h. p. motor, consisted of machine cut, cast steel gears and rawhide pinions. These gears had been lubricated with a popular brand of gear shield and also with graphite grease. The superintendent, however, reported that very poor results had been secured from both of these lubricants. It was necessary to clean from these gears deposits left by the former materials before applying Crater Compound. The results from the use of Crater were so satisfactory that all of the gears in this particular department were immediately turned over to be lubricated with Crater Compound.

In this mill there are two sets of herringbone gears, these gears running 52 r. p. m. and the pinions 485 r. p. m., being driven by a Westinghouse 300 h. p. motor. In December, 1916, one of the sets of gears was started, using a special gear oil. A week later the second set was started with Crater Compound. The first of February, after about two months' operation of these herringbone gears, the covers were lifted from both gear cases and the gears were carefully examined. Examination showed that the gears lubricated with Crater Com-

pound, owing to the pinion being somewhat out of line, were bearing on about a four-inch surface of each tooth. The gears, however, were in fine condition, not the slightest sign of wear being apparent notwithstanding the handicap of the pinion being out of line. The gear case having the competitive oil in use was then examined. The pinions and gears were properly in line with a bearing surface the full length of the tooth, but the teeth on the pinion, on being calipered, showed a wear of approximately one-sixty-fourth of an inch.

These two sets of gears were operated side by side under identical conditions, the only difference being the method of lubrication. The incident shows that Crater Compound will take care of gears even if they are not perfectly lined up. The preliminary work done by Crater Compound on this mill has been of such a satisfactory nature that the mill has now adopted this gear lubricant throughout.

TEXACO SERVICE

LIKE the good rule that works both ways, our lubrication engineers are serving splendidly both the Company and its customers. As an instance, we cite a few experiences related by Mr. Salbador in his paper on "Engineers New in the Oil Business" read at the Third Annual Meeting of Lubrication Engineers held at New York, October 11th to 14th, 1916.

"The lubrication engineer will find that where a lubricant is condemned it is generally due to the operating engineer being unfamiliar with the lubricant or to an improper assembling of the machinery. This explains the importance of having our lubrication engineers on hand when our lubricants are being introduced.

"On one of my visits to a large plant in the Chicago District, which had been in operation about five weeks, the Guarantee Engineer for the engine builders complained of our Canopus Oil emulsifying. I found, upon investigation, that the piston rods were receiving a steady stream of cylinder oil, which ran off into the engine pits and became mixed with the engine oil. This mixture was being reclaimed and used again for lubricating the working parts of the engine. I suggested that the emulsion complained of was due to this excessive amount of cylinder oil being mixed with the reclaimed engine oil. Drains were then installed to catch the cylinder oil in a separate tank, and immediately the engine oil began to clear up. I also advised that the consumption of cylinder oil be cut down as the excessive quantity used was ruining the reclaimed engine oil.

"In a steel mill where they were using Crater Compound with very good results I explained fully how this lubricant should be applied, and when, about a week later, I called again, the millwright showed me his figures where he had used 480 pounds of Crater Compound as against 1,320 pounds of the lubricant formerly used, a reduction of 63⅔ per cent. in consumption, and he was confident that when he became more familiar with Crater he would be able to effect an even greater saving. He also said that for the Crater Compound two oilers were sufficient, while formerly three had been necessary."